#552



United States Department of Agriculture
Region 8, Soil Conservation Service
Albuquerque, New Mexico

Part II

Text for Students

on

# CARE AND OPERATION OF TRACTORS

for

C.C.C. Training Course

Compiled by

J. T. Bonner

U. S. Forest Service

Adapted for Soil Conservation Service Use

by

Dale R. Shockley

Regional Bulletin No. 19
Training Series No. 4
October, 1937

(Student's Copy)

# CARE AND OPERATION OF TRACTORS

## PURPOSE AND INTRODUCTION

## LESSON I

The purpose of this course is to instruct the enrollees in the general care and operation of gasoline motor-powered tractors. It is one of the basic courses being presented in the Region in an effort to enable the enrollee to perform his present duties in a more workmanlike manner, and to prepare him to fill a like position after he returns to civil life.

This training will be of material benefit to the tractor operator since it will prepare him to take up repair and more advanced phases of his field. The Soil Conservation Service will receive a direct benefit from the training since the operator will be able to do better work and to reduce the operating expenses of the equipment.

Close observation in the field has shown that approximately one half of the lost time and maintenance costs of tractors operated in C.C.C. camps might have been avoided if the men on the tractors had had the proper training or experience. It is not possible to make a tractor operator in a class room but information can be given and knowledge can be gained there that will help in the practical field work.

This course has been purposely simplified, so that it may be easily understood. It will form a sound basis for the enrollee who has some natural ability in handling heavy equipment, and who wants to know more about it.

The materials which make up the lessons have been taken from numerous service manuals published by the manufacturers of tractor equipment being used by the Soil Conservation Service and from information received from men actually in charge of tractor operations. The course is not intended to prepare the student to operate any one type or make of tractor, but to give him a general knowledge of the care and operation of all tractors. Special stress, however, will be placed on instruction in the care and operation of the particular tractors used in camp. Safety and safety practices will be referred to all through the course and failure to comply with them will be sufficient reason to relieve a tractor operator. The majority of accidents caused by tractors and the heavy equipment are those that result in serious loss of time or fatalities. All of these accidents could be avoided. If a tractor is not safe to operate it should be repaired and put in a safe operating condition before it is used again.

A tractor operator should be mechnically inclined or adapted to this particular class of work. He should be sound physically, his sight and hearing should be very good, and his mentality such that he can understand orders and carry them out. He should be dependable and able to control himself in an emergency.

Lack of self-control, or losing his head in an emergency might result in injury to himself and others, as well as damage to the machine he is operating.

In other words, he should have a lot of what is commonly referred to as "horse sense".

OPERATION OF TRACTORS

The operation of tractors as used in the Soil Conservation Service is in three general classes: namely, straight draw-bar work; providing power for auxiliary equipment such as rock crushers and compressors, and operating trail builders etc. Draw-bar work consists generally in pulling a grader, ripper or fresno; therefore, a new operator should be started in this class of work. This will enable him to learn to start, stop, and steer his tractor automatically so that he can devote his entire attention to the work being done.

When used as a powerplant the operator should not only watch the tractor but also, the rock crusher, compressor, or other equipment being operated, and be in a position to stop the tractor or cut off the power immediately in case of an emergency. Tractors are equipped with a power take-off, and the power is transmitted directly by gears or with a pulley and belt.

The third and most complicated or difficult operation of a tractor is in connection with a trail builder or hoist. When used in connection with a trail builder, the operator must not only understand the operation of the tractor perfectly, but must understand the moving of dirt and rock. Otherwise he cannot accomplish the maximum amount of work the tractor is capable of doing.

Tractors are of two general classes: the wheel type and crawler type. The wheel type is not in general use except on motor patrols or on some few old tractors which are used principally for power plants to operate compressors or rock crushers. A wheel type tractor does not have sufficient traction, and is difficult to maneuver in any class of heavy work, and, in most cases, is being replaced by the crawler type.

The crawler type has an endless track which is turned by drive sprockets, and the weight of the tractor is distributed over a much larger area thus increasing the traction in proportion. Locking one of the tracks on this type tractors permits the tractor to be turned or maneuvered in a very small space. Types that can be turned completely around in their own length are by far the most practical, and this course will pertain to them principally.

## CLEANING AND LUBRICATION

### LESSON II.

This is one of the most important lessons in this course. The life of the tractor and operating expense of same will depend largely upon whether it is properly cleaned and lubricated. It is impossible to over emphasize this point. Time used in cleaning and lubricating a tractor is well spent and will eliminate many costly repairs.

The following are some of the excellent reasons for thoroughly cleaning a tractor:

1. A clean motor runs cooler.
2. Loose and broken parts are more easily detected.
3. Wear is reduced on moving parts.
4. A clean motor is easier to repair.
5. Fire hazard is roduced.

The first operation in cleaning a tractor is to scrape all mud, grease, and dirt from the motor as well as from the tracks and other parts. Where water is available, a tractor should be thoroughly washed off with a hose; then all grease should be removed with a cleaning solvent. In cleaning do not use gasoline or other inflamable agents which will create a fire hazard.

At least once a week the motor should be thoroughly cleaned with solvent, and each day all grease and dirt should be wiped off with a rag. In some cases where a tractor is old and leaks oil badly, it is necessary to clean with solvent much oftener to prevent the grease and dirt from caking.

Care should be taken to see that all grease and dirt is removed from the dust pan below the motor.

A convenient method of cleaning a motor is to use an old paint brush and an open bucket of solvent. Where the grease and dirt has become caked, a wire brush will work very effectively. Care should be exercised not to scrape the paint off in cleaning, as a painted surface is much easier to keep clean. Care should be taken in cleaning the starter with a wire brush or other metal implement as it is very easy to short circuit the battery cable connection at this point and to start a fire.

The cleaning of a motor is not a very complicated operation, but it should be done thoroughly and a certain amount of knowledge and judgement is required. If done regularly, one or two gallons of solvent should be sufficient to clean a motor.

The next step in cleaning the motor is to remove and thoroughly clean the air cleaner. This should be done daily especially in dry, windy weather. After the cleaner has been cleaned, fill it to the proper level with light motor oil and securely fasten it in place. In performing this operation, inspect all connections and see that between the air cleaner and the carburetor there are no leaks through which the motor might draw in sand of dust.

Every fifteen to thirty days, depending upon the dust conditions, the whole cleaner should be removed and washed with solvent.

It should then be saturated with a light motor oil. A tractor motor will operate even if the air cleaner is very dirty, leaking, not functioning, or completely disconnected; consequently, it is necessary to inspect it frequently. A motor can be ruined in one day if it is operated under very dusty conditions without an air cleaner that is working properly.

The oil filter should be removed and washed with solvent every time the oil is changed.

The breather caps should be removed and cleaned with solvent daily and saturated with a light motor oil.

The next step in cleaning the tractor is to clean the body of the tractor down to the tracks and track frame assembly. All mud, grease, and caked dirt should be scraped or wiped off and the parts then washed with solvent. This is a simple but important operation. While cleaning the tractor, the operator should make a thorough inspection of all parts to see that they are tight and free of any breaks or defects.

The last part to be cleaned is the track assembly. All caked dirt and grease should be scraped off and all excess grease washed off with solvent. It is not practical to keep the track assembly absolutely free from mud, dirt, and grease, but at least once a week it should be cleaned thoroughly and a careful examination made of all parts to see that they are tight and working properly. In freezing weather, it is very important to see that all mud is removed from both the top and the bottom track rollers at night or whenever the tractor is shut down.

If this is not done, the mud will freeze, and when the tractor is started, the rollers will fail to turn and the tracks wear a flat place on them. It then becomes necessary to replace the track rollers.

Inasmuch as graders are operated in connection with the tractors, it is logical to clean them when the tractor is cleaned. The same method of cleaning applies to graders as to tractors. By doing the cleaning the operator has an opportunity to inspect the equipment for loose or defective parts.

Tractors and graders are large cumbersome pieces of equipment, but they require the same care, attention, and adjustment as a smaller or more delicate machine. For this reason, a great deal of emphasis is being placed on keeping them clean and properly lubricated.

PART II

No set rules will be laid down in this lesson concerning the lubrication of any certain kind of tractor or the grade of oil or grease to use, as each type or model tractor requires different lubricants. The idea is to stress the importance of lubrication, to explain what it is, and how it should be applied.

The purpose of lubrication is to prevent any two pieces of metal that work one against the other from touching by having a film of oil between these. Upon this film of oil depends the life of the bearings, cylinder walls, piston, and the working parts.

A piece of equipment cannot be properly lubricated unless the correct grade of oil or grease is used. The grade should be determined from the lubrication chart published by the manufacturer, and in all cases the one designated should be used.

It is the general opinion among lubricating engineers that more motors are ruined by using an oil that is too heavy, than from any other cause. Motors and other working parts are set up with much less clearance than they were a few years ago. It is possible to have plenty of oil in a motor and yet not properly lubricate it if the oil is too heavy.

The first part of a tractor to be lubricated is the motor. When it becomes necessary to change oil in the motor remove the drain plug from the oil sump and drain the oil while the motor is hot. At intervals it may be necessary to flush the crank case. When this is necessary, replace the drain plug and pour two gallons of flushing oil into the crank case. Run the motor three or four minutes and then drain, flushing oil. Replace the plug and fill the motor to the correct level with the correct grade of oil. Never flush a crank case with kerosene or gasoline as a part of it will remain in the oil sumps and dilute the fresh oil.

The next step is to lubricate the water pump. This should be done every time the oil is changed and only water pump grease should be used. It might be necessary to screw the grease cup down two or three times per day on some tractors, especially if the water pump shaft is worn.

The last step in greasing the motor is to put a few drops of light oil on the generator, starter, and magneto as called for in the lubrication chart. There are a few controls and other moving parts on some types of tractor that require oil or grease. It is necessary on some types to grease the fan.

After the motor has been lubricated, the chart should be checked carefully and the clutch throw-out bearing, steering clutches and all other parts of the tractor body should be carefully greased with the correct grade of oil or grease.

The last part to be greased is the track assembly, and as this whole assembly works continually in dust and mud, the importance of regular and proper lubrication cannot be over emphasized. On some tractors being used by the Soil Conservation Service, this whole assembly is lubricated at one operation by the "One Shot System". This consists of an oil reservoir and a hand pump with lines leading to all parts to be lubricated; when working properly, this is a very simple and convenient method of lubricating the track rollers and idler assemblies. When operating a tractor equipped with the "One Shot System", the operator should inspect the whole system daily to see that none of the oil lines are mashed or broken and that oil is reaching all parts. The only grade of oil to use in this system is that recommended by the manufacturer.

The conventional type tractor that is in general use has a separate plug or grease fitting for each track roller or idler wheel.

Different tractors use different grades of grease, as some of these bearings are of the roller type and others are bronze bushings. In order to prevent forcing sand or dirt into the bearings with fresh grease, all dirt and grease should be removed from the fittings before an attempt is made to grease them.

When greasing the track rollers and idlers, do not stop with one or two shots of grease but continue pumping grease until it runs out of the bearings, This is very important on this entire assembly as this fresh grease carries the dust, sand, and grit out of the bearings that will naturally work into them. If the bearing is so tight that grease cannot be forced out, be sure that the bearing is taking grease. Ordinarily this can be determined by the back pressure in the pump.

When some types of tractors are used as power plants, it is necessary to provide special lubrication for their power take-off. When a tractor is used for this purpose, check the instruction book for this particular tractor and follow the manufacturers instructions. In fact the instruction book and lubrication chart put out by the manufacturers should be carefully studied and followed when lubricating any piece of equipment. Another point which might be brought out at this time is the proper method of stopping a tractor, as it concerns the proper lubrication of the motor. Always cut off the gasoline and allow the motor to stop with a hot spark as this prevents pulling raw gasoline into the motor which washes the oil from the pistons and cylinder walls and dilutes oil in the crankcase.

The grader or other equipment being used in connection with the tractor, should be greased at the same time the tractor is. The same general rules should be followed and in all cases follow the manufacturers instructions and lubrication charts.

Under no circumstances start a tractor motor without first checking the oil level in the crankcase. If someone has drained the oil, the motor will be burned up before you learn that there is no oil in the crankcase.

# COOLING SYSTEM

## LESSON III

The cooling system of a tractor consists of the radiator, water pump, fan, and the water jacket of the motor. The purpose of the cooling system is to control the heat that is created in the cylinder head by the explosions and compression. If no provisions were made to control this heat, the motor would become overheated and it would be impossible to properly lubricate it.

All internal combustion motors operate more efficiently when warm. The cooling system for each type tractor is designed to maintain the correct operating temperature. When the temperature rises above normal, the motor should be stopped immediately and the cause of heating determined. If a motor is operated when overheated, serious damage may be done to the bearings, pistons, and cylinder walls. If the operator cannot determine the cause of overheating, he should not operate the tractor until a mechanic has checked it and corrected the trouble.

### Radiator

The radiator consists of a cellular or tubular core with a reservoir at both top and bottom. When the motor starts, water is drawn from the bottom of the radiator and is forced upward through the water jacket of the motor into the top of the radiator. The water is effectively cooled by circulating through the core where it is exposed to a much greater external

surface. The tubes carrying the water through the core are cooled by the fan which pulls cool air around and between them.

The radiator ordinarily does not require a great deal of care, other than keeping it tight and clear. The anchor bolts and brace rods to the radiator should be kept tight at all times to prevent vibration which would cause the core to break and leak.

The radiator should be flushed at regular intervals to prevent the core from becoming clogged with foreign matter that would reduce the cooling capacity. This can be accomplished by disconnecting the lower radiator base and flushing the radiator with a hose under ordinary pressure.

Whenever possible use soft water in the radiator to prevent scale from forming in the core and water jacket. When hard water is used the mineral precipitates out of the water which forms the scale. A core that is plugged with scale can be detected by feeling it when the motor is hot; the lower section will be cold while the top is quite hot. This trouble can be overcome by using different radiator cleaners or solvents to dissolve the scale. After it has been in the cooling system the required time, the lower base should be disconnected and the system flushed well with clean water.

Bugs, grass, leaves, or dirt should never be allowed to collect on the front of the core as they will block the circulation of air through the core and reduce the efficiency of the radiator.

When a radiator leaks, no attempt should be made to stop the leak with meal, bran, or other stop-leak preparations; such preparations have a tendency to clog the core and stop circulation. The radiator should be removed and the leak soldered.

The fan and water pumps are as important as the radiator and require regular attention. Ordinarily the water pump is mounted on a bracket on the side of the motor and is driven by the magneto drive shaft. The pump should be lubricated regularly and the packing glands drawn up snug but not set too tight. If they are the packing will burn and the pump will be seered. A leak in the pump may be stopped by lubrication or by tightening the glands a little. Some types of tractors make no provision for lubricating the water pump but in all cases the instructions given by the manufacturer should be followed.

Some tractors are equipped with a gear-driven fan; they require no special care as they cannot get out of adjustment and are lubricated from the gear case on the front of the motor. Others have the fan mounted on a bracket and are driven from a pulley on the crankshaft or magneto drive shaft. This type fan requires regular lubrication and adjustment. It should be adjusted tight enough to prevent the belt from slipping, which is not very tight when V type belts are used. Both gear and belt-driven fans, should be regularly inspected to see that the blades are tight on the hub.

All base connections on the radiator and water pump should be checked daily to see that they are not leaking or that they have not cut off circulation by collapsing. When the motor is started, the water level should be checked in the radiator. The tractor should never be operated without water. When anti-freeze is used in the radiator, it should be checked regularly with a hydrometer to see that it is of the proper strength to prevent freezing. If the cooling system is drained in cold weather, the water pump and water jacket should be drained as well as the radiator. The motor should not be started until it is known that the water pump is not frozen, as the impeller-shaft shear keys on same may be broken.

When the water is low and the motor is overheated, the motor should be cooled and then run slowly while the radiator is filled. If this precaution is not taken the cylinder head or block assembly may be broken.

## IGNITION AND CARBURETION

### LESSON IV

All tractors in common use by the Soil Conservation Service at this time are equipped with a high-tension magneto. This magneto, spark plug wires, and spark plugs make up the ignition system. Ordinarily the magneto is equipped with a ground wire and switch for stopping the motor, but usually the motor is stopped by shutting off the gas supply. The magneto method of ignition is very simple and if the system is given proper attention it will cause very little trouble.

A high tension magneto delivers a hot spark when it is rotated, and no coils are required. An impulse is attached to the magneto which, by use of a spring, turns the magneto over quite rapidly. This is necessary in starting a heavy duty motor such as is used on tractors, because it is not possible to turn the motor over fast enough with the crank or starter to attain the required speed for the magneto to generate a hot spark. When the motor starts, contrifugal force disengages the impulse and the magneto drives direct.

The interrupter assembly of a magneto consists of the breaker points and the base on which they are mounted. Rotation of this whole assembly causes the points to break at regular intervals and distributes the current to the spark plugs when the piston has reached the firing points on the compression stroke.

The breaker points should be adjusted so as to have a clearance of approximately .015 of an inch when they are fully opened. If the points are not properly adjusted or are burned or pitted, the motor will not fire evenly or develop its maximum power. A magneto is a delicate part of the tractor and ordinarily should not be worked on by any one other than an experienced mechanic. It should be kept clean and free from grease, dirt, oil, and water at all times. Occasionally a few drops of oil should be put into the bearings. Under severe operating conditions, it is a good idea to cover the magneto with a water-proof canvas or rubber hood to protect it from moisture and dirt.

A magneto may be in perfect condition and delivering a hot spark, but if it is not timed perfectly with the motor, the motor will fail to start or to deliver its maximum power. Instruction books on all tractors explain in detail just how this should be done. These books should be referred to when timing a motor. The general principal to follow, when no instruction book is available, is to turn the motor over slowly with the crank until the piston of No. 1 cylinder eases up on the compression stroke. There is a firing mark on the fly wheel which should be at the indicator or the center of the inspection hole. This is the firing point for this cylinder. The magneto should be turned over until the points are just breaking on the contact for No. 1. The magneto connection should then, when it is properly timed, be securely fastened. Unless the connection is stripped or

the magneto is taken loose, there is no way for it to get out of time. The average operator should never interfere with the timing of his tractor.

If a motor starts hard or does not fire regularly, the trouble probably is in the spark plugs. Tractor motors run pretty hot, and the spark from a strong magneto will soon burn the electrodes of the plugs. Burned points have too much clearance and create so much resistance that the spark cannot pass between them. The electrodes should be cleaned and adjusted to .025, and if the plug still fails, it should be replaced with a new one. Under ordinary conditions, the spark plugs of a tractor should be replaced with new ones after about 300 hours of operation. The plugs may still fire, but their efficiency is reduced. There is no economy in using old plugs as they increase the gasoline consumption.

Never attempt to overhaul a magneto on the job, but send it to an authorized and experienced magneto repair shop.

Carburetion

Trouble from the carburetor is not as common as ignition trouble, and if the operator has a few tools, he can generally overcome this trouble on the job. The fuel system consists of fuel tank, fuel line, fuel pump or vacuum tank, sediment bulb, and carburetor.

If trouble develops when there is plenty of fuel in the tank and the operator is satisfied that the trouble is lack of, or poor carburetion, he should check as follows: If no gas is present at the carburetor, check the fuel line

to see that it is open to the fuel pumps. If the gas line is stopped up, it can be cleaned by blowing out with a tire pump. If the line is open, the fuel pump can be tested by disconnecting the supply line to the carburetor and turning the motor over with the starter or crank. If the pump fails to work, its trouble is usually caused by a perforated diaphragm, and a skilled mechanic should replace it with a new one.

If the fuel is traced to the carburetor but does not get through to the motor, the trouble may be caused by the screen in the carburetor being clogged. This can be easily cleaned.

Water and dirt in the sediment bulb will often cause a motor to miss or die. This is easily overcome by removing the sediment bulb and cleaning it. In cold weather, water in the sediment bulb or gas line may freeze and prevent the fuel from flowing. When this bulb has been removed for any reason, it should be replaced carefully, so that it will not leak around the gasket.

If fuel is present in the carburetor but the motor misses, the trouble may be caused by dirt or water in the jets. Sometimes this can be overcome by speeding up the motor and pulling out the choker with the throttle open for about two seconds. If this does not overcome the trouble, the carburetor should be taken down by a skilled mechanic and cleaned.

When the carburetor floods or too rich a mixture goes into the motor, the float or float valve usually is sticking. This difficulty can be overcome sometimes by lightly tapping the carburetor bowl.

Vibration quite often breaks gas lines, on tractors. A tractor should never be operated with a broken or leaky gas line as this creates another fire hazard.

Starter and Lights

Some of the tractors now in use by the Soil Conservation Service are equipped with a generator, battery, starter, and lights. This sytem requires a certain amount of regular attention and should not be neglected. The generator and starter should be kept perfectly clean, dry, and free from oil and grease at all times and should be lubricated with light oil. The battery terminals should be kept clean and the plates should be covered with distilled water at all times. The wiring and light connections should be checked daily to see that there are no short circuits which might run the battery down.

If this syten gives trouble, the operator should not attempt to make any repairs as this system is rather complicated and requires the services of a skilled mechanic. If the starter becomes sluggish and does not turn the motor over as it should, the trouble is generally caused by a weak battery, or by worn bearings which allow the armature drag.

Whether the generator is working can be determined

by watching the amperemeter. If for any reason the lead to the battery is broken, the generator should be grounded to avoid burning.

## TRANSMISSION AND FINAL DRIVE

### LESSON VII

The transmission has two functions, one is to change the direction of the tractor from forward to reverse, and the other is to control the power and speed of the tractor.

The transmission is located directly behind the master clutch. The power is transmitted directly from the clutch shaft to the upper transmission shaft. The type used on most tractors is practically the same as a standard, three-speed automobile transmission. This consists of the upper drive shaft, the counter shaft, and reverse, idler gear shaft. The power is transmitted from the main-drive pinion to the counter-shaft driving gear. These gears are always in mesh. By using different combinations of large and small gears on the counter shaft and the bevel pinion shaft, the different speeds are attained. These gears are shifted on spline collars on the two shafts.

The power of the tractor increases in proportion to the decrease in speed to the pinion shaft as controlled by the different sized gears. For instance the low-speed driving gear on the counter shaft is a small gear which is meshed with the low-speed driven gear which is several times larger. If the driven gear is three times as large as the small drive gear, it will require three revolutions of the drive gear to turn the pinion shaft over one time.

When the ordinary transmission is driven in high gear, the drive is usually direct. That is, the speed of the pinion drive shaft is the same as that of the motor. As the speed of this shaft is reduced by the transmission gears, it is easy to see why the tractor develops more power in the lower speeds.

The direction of the pinion gear shaft is reversed by engaging the reverse gear with the reverse idler gear which is in mesh with the reverse drive gear.

The foregoing explanation has been given, so that the operator will have a general idea of how and why a transmission works. It is a very essential unit of the tractor and the operator should understand the principal.

The gears on the transmission are controlled or shifted by means of a collar on the high speed and low and reverse driven gears. The shift lever is connected to shifting forks over the collar on the driven gears. The transmission can only be engaged in one gear at a time; it is necessary to bring the shifting lever to the neutral position before the jack can be engaged with another gear.

The transmission requires no adjusting and very little care other than to be properly lubricated. The transmission should be drained and thoroughly washed twice a year with a cleaning solvent. The case should be drained of all solvent and refilled with the proper grade of oil or grease recommended by the manufacturer. It is suggested that this be done in the fall of the year and that lighter weight

grease be used during the winter. In the spring the case should be drained and refilled with summer-grade grease.

The operator should at all times see that the cover and inspection plates are securely fastened down, so that no dirt can enter the transmission case. The transmission should be checked regularly to see that it is not leaking grease and that the grease is at the proper level. More than the required amount of grease should never be put in the case or it will leak out and cause trouble.

In operating a tractor, especially in connection with a trail builder, no attempt should be made to shift gears until the clutch has stopped or is completely disengaged. Such an attempt would cause the gears to grind and soon wear so badly that they would not remain in mesh when the power is applied. Operation of a tractor in a speed too high causes the motor to labor. Stopping and shifting to a lower gear will save both the motor and transmission.

Final Drive

The final drive is an arrangement of gears and shifts to transmit the power from the transmission to the drive sprockets which in turn drive the tracks. Ordinarily, the drive pinion is secured to the transmission and drives the ring gear. The gear is a larger, bevel-cut gear and the first speed reduction occurs between this gear and the pinion gear which is much smaller.

In the type tractor using a differential, the ring gear is bolted to the differential cage and the power is then transmitted to the axles. The intermediate spur gear which is comparatively small, is mounted on the end of the axle. The power is then transmitted to the spur gear which is a large gear. This gear and pinion is mounted in a heavy, steel housing and the drive sprockets are on the outer end of the shaft supporting the spur gear. A further gear reduction is effective through the spur gear and pinion.

This type final drive operates in an oil-tight housing and runs continuously in an oil-grease retainers which are provided to prevent the oil from leaking out of the housing around the drive sprockets. The steering brake bands and drums run in oil also in this type tractor.

Tractors using steering clutches operate practically the same as the differential type. The speed is reduced through the ring gear and pinion and the spur gear and spur pinion. The ring gear and pinion are in an oil tight case and run in oil. A space is provided between this case and the spur gear case for the steering clutches and brakes which operate dry. The spur gear case is oil tight and these two gears run in oil.

The final drive of a tractor is very similar to the transmission as regards to care. There are no adjustments to be made by the operator and proper lubrication is about all the operator has to watch. Inspection plates and covers should be kept tight at all times to prevent grease from leak-

ing out and dirt from entering. They, the same as the transmission, should be drained and thoroughly washed with cleaning solvent twice a year. The grade of oil or grease used should be checked against the manufacturer's lubrication chart of the correct grade for summer and winter.

The inspection plates should be removed at regular intervals by a skilled mechanic and the clearance between the ring-gear pinion checked. At the same time the axle bearing should be checked to take up the end play. The drive sprockets should be checked regularly for any play which can be taken up with metal shims.

On tractors that have the drive sprockets bolted to the hub, it is necessary that those bolts, as well as all studs or bolts holding the final drive housing in place, be checked every week to see that they are tight. This should be done every time the oil level is checked on the transmission and final drive. This lesson will require considerable discussion in class and an old track or automobile transmission and differential should be available for demonstrating the lesson.

## GOVERNOR AND OTHER MOTOR PARTS

### LESSON V

All tractor motors are equipped with a governor which controls the operating speed of the motor. All tractors now in use have mechanical governors that are controlled by centrifugal force. The purpose of the governor is to automatically speed up the motor when the load is thrown on it and to reduce the speed in proportion when the load is taken off. If there was no governor on a tractor motor, the operator would have to open and close the throttle every time the tractor load was changed.

The governors are set at the proper operating speed and sealed before they leave the factory and under no circumstances should an operator break the seal and try to make any adjustments.

The governors consist of fly balls or weighted arms mounted on a shaft driven direct by a gear in the timing-gear case. These arms are held together by springs, and as the motor speeds up, the centrifugal force throws these weights to the outer position which in turn moves a pin that is connected to a rod which controls a butterfly valve in the carburetor assembly. The adjustment in the governor is controlled by the tension on the governor springs. Governors are adjusted differently according to types.

Under ordinary circumstances the governor requires no attention other than the proper lubrication.

If the motor does not maintain a uniform speed or the motor is not operating at the rated speed, a skillful mechanic should inspect it and, if necessary, make repairs or adjustments.

Oil Pumps and Gauge

Tractor motors are all equipped with an oil pump and the majority of them use the force-feed lubrication system. This system consists of the pump which picks the oil up from the oil sump in the crankcase and forces it through lines to the points to be lubricated. The crankshaft is rifle bored, and oil is forced into it through one or more main bearings where it flows to the connecting-rod bearings.

The excess oil from the bearings is forced out under pressure in a fine spray which in turn lubricates the cylinder walls and wrist pins. Copper tubes carry oil to the timing-gear case, cam-shaft bearings and other parts not lubricated by the excess oil from the bearings.

The oil pump is a gear pump driven from the cam shaft or other shaft and is equipped with a pressure relief valve to control the oil pressure. This valve is set at the factory for the correct pressure required by each type motor and should never be changed by the operator. If it is necessary to make an adjustment of this valve, only an experienced mechanic should attempt it.

The operator should know the correct oil pressure for the tractor he is operating and should watch the oil gauge to see that this pressure is maintained at all times.

If the pressure drops or fails to register on the gauge, the tractor should be stopped at once, and a mechanic should determine the trouble and make the necessary repairs before the motor is started. This may be caused by thin or diluted oil, by the gears being worn in the oil pumps, or by too much clearance in the main or connecting rod bearings.

Connecting Rod and Main Bearings

Since the life of the bearings depend entirely upon their being properly lubricated, the operator should have some knowledge of them, although he should never attempt to adjust the bearings. This operation should be done only by a skilled mechanic.

Tractor motors are slow in speed as compared to other automotive type motors and the clearance on the bearings in most cases is greater. They require a heavier grade of oil than does the automobile.

The bearings should be set at the clearance the manufacturer recommends as they will lose oil pressure if too loose and will burn if set too tight. Bearings can be adjusted to the proper clearance and still lose oil pressure if the proper kind of shims are not used. Use only shims made for the particular type motor being worked on. These shims are generally a laminated brass shim with a babbit surface next to the crankshaft that is cut the same shape and size as the bearing cap. Never use pieces of tobacco cans or such material to shim a bearing.

If in an emergency, an operator or mechanic has to adjust a bearing and no instructions for that particular motor are available, the following rules can be used to determine the clearance: one thousandth of an inch clearance should be allowed for each inch of diameter of the crankshaft. This may not figure out exactly with the manufacturer's recommendation, but it will be very close to it.

A loose bearing can sometimes be detected by loss of oil pressure and when it becomes burned or very loose, it creates a knocking sound which is easily identified. When a bearing becomes loose enough to knock, the motor should be stopped and not started again until the needed repairs are made. If a motor is run with one or more loose bearings, it will cause the crankshaft to wear out of round, and it will be impossible to adjust the bearing. When an operator detects any knock or peculiar noise in the motor, he should stop it and have a skilled mechanic check it carefully and determine the cause.

Motor Compression

The power a motor develops is controlled to a large extent by the compression it has. If the compression of a motor is less than that rated by the manufacturer, the motor will not develop its rated horsepower. The compression is controlled by the valves and the piston and rings.

If the valves become burned or pitted, compression is lost through them into both the intake and exhaust manifolds. The loss of compression through the valves can be detected if

a hissing sound is heard in the manifold when the motor is turned over slowly.

The push rod or tappet adjustment for each valve should be set at the clearance recommended by the manufacturer. Valves should never bet set too tight as they expand when the motor becomes hot and will hold open. If this happens they will burn and compression will be lost.

If the correct clearance is not known no damage will result if the valves are set with plenty of clearance.

The piston rings create a seal between the piston body and cylinder walls and also prevents oil from being pumped into the combustion chamber. Piston rings are set with a certain clearance so that when the motor becomes hot and the rings and pistons expand, they will not fit too tight.

If the rings and pistons become worn or have too much clearance, the motor will generally use or burn a great deal of oil and compression will be very weak. This can be determined in much the same way as leaking valves, only a hissing sound will be heard in the crankcase. This can be remedied only by new rings or new rings and pistons. If, as is generally the case, the cylinders have worn out of shape, it is necessary to replace the block assembly or regrind it.

Weak compression can be determined very easily by turning the motor over slowly with the crank. It will turn over much easier on some cylinder that it will on others. A burned valve or broken rings on one or more cylinders will cause these

cylinders to be weak while the others are normal, and the motor will miss or run unevenly.

## MASTER AND STEERING CLUTCHES

LESSON VI

The purpose of the clutch is to enable the operator to supply the driving mechanism of the tractor with the power generated by the motor. The clutch governs the application of the power of the engine to the transmission and is operated by a foot pedal or hand lever. Practically all tractors in use are equipped with a multiple disc, dry-plate type clutch.

This type consists of the driving discs which are fastened to the fly wheel by pins on a ring and the driven discs which are mounted on a spline shaft. This shaft extends through the entire assembly and is supported on the front end by a pilot bearing which is mounted in the center of the fly wheel. The rear end of this shaft is supported by a bearing in the transmission case, and the shaft is connected directly to the transmission. The power which engages these plates generally is supplied by a series of coil springs, but in some instances by an excentric action.

The driven discs are fastened to the clutch which is splined to slip on the clutch shaft. The clutch hub is equipped with a throw-out bearing and collar, and it is at this point that the clutch is controlled.

Either the driven discs or the drive discs have a composition facing while the other discs are smooth, steel rings or a heavy, cast-steel plate depending upon the type clutch.

The friction or power which holds the plates together when the clutch is engaged is supplied by these facings. The wear is on the facings or clutch linings; if they are not replaced they will burn, or become glazed.

There is a brake on the clutch hub which is forced against a stationary plate when the clutch is disengaged. This generally consists of a small disc with a composition facing and the stationary disc is a smooth, steel plate. The purpose of this brake is to stop the clutch from turning when it is disengaged to shift gears. If the clutch is too tight or the facing is burned or worn on the clutch brake, the clutch will fail to stop when disengaged.

Ordinarily the clutch requires very little attention other than being properly lubricated. In most cases, there is a grease fitting on the clutch. On exposed clutches, a tube extends from the hub to the outside of the case. The clutch shaft is rifle bored and the grease enters the shaft by an opening through the shaft and hub to lubricate the pilot bearing and the clutch throw-out bearing. It is sometimes hard to get much grease through to the pilot bearing which is usually a light bearing and not designed to run continuously. An operator should never leave the tractor in gear with the clutch disengaged. To do so is to cause unnecessary strain and excessive wear on both the pilot and throw-out bearing.

When the tractor is stopped and the motor is to run idle, always place the gear shifting lever in the neutral position and engage the clutch. This is a very important point and

if not practiced will result in costly repair and lost time.

Occasionally the clutch facings become gummed or greasy from excess grease and dirt, and because of this they slip or some times grab or drag when the clutch is disengaged. This trouble may be overcome by kerosene or cleaning solvent being squirted from an oil can between the plates while the motor is idling and the clutch is disengaged. If the clutch is slipped gently the solvent will be distributed over the plates and the foreign matter will be loosened. It is a good idea then for the motor to be stopped, the clutch disengaged, and enough solvent poured and squirted between the plates to wash off the loosened dirt and grease. The clutch should be left disengaged so the plates can dry out, and the drain plug on the clutch housing removed so that the solvent can run out. The clutch should be well lubricated before the tractor is again placed in use. Gasoline should never be used to clean a clutch as it creates an unnecessary fire hazard.

When a clutch slips, grabs, or fails to disengage, the operator should not attempt to adjust it. The clearance between the discs and on a clutch is very slight and the adjustment is naturally a fine one that should be made by a skilled mechanic. When trouble is first detected in the clutch, the tractor should be stopped, and the condition reported to the mechanic as it is possible for an entire clutch assembly to be ruined or burned up if it is operated when it is slipping.

Steering Clutch

Crawler-type tractors are steered by stopping one

track or slowing down while the other track crawls around at the normal speed. For instance, the tractor can be turned to the left by disengaging the power and locking the left track until the right track has crawled around to the direction desired.

This is accomplished in two ways. One type tractor has a differential very similar to that of an automobile or truck, except that it is of much heavier construction. Each axle is equipped with a large brake drum and an external, contracting brake band. To turn the tractor, the operator simply applies pressure on the brake drum which slows or stops the track while the other track is permitted to turn at the normal speed.

The other and most satisfactory type has no differential, but drives direct to each track. Each live axle has a multiple, dry-disc clutch, brake hub, and band. To turn the tractor, the operator disengages the steering clutch on the side he wishes to turn toward, and the other track crawls around in the desired direction. If he wants to make a sharp turn, pressure is applied to the brake drum on the track. With this type steering, it is possible to disengage the steering clutch, lock the track with the brake and turn the tractor completely around in its own length. Under no circumstances should an operator apply the brakes on this type tractor without first disengaging the steering clutch on that track. To do so would only burn out the brake bands since the clutch is a direct drive and cannot slip.

On the differential, or first type discussed, the steering mechanism requires very little attention or care. Ordinarily the final drive and steering brakes operate in an oil filled case or housing and require no care other than to be properly adjusted. There is an adjustment on the brake band which should be set up so that there is no slack between the pedals and the brake bands. Any adjustments that are necessary should be made only by an experienced mechanic as it is possible to burn out a set of brake linings in a very short time if they are set up too tight.

Tractors that are steered in this manner require very little attention so far as the steering mechanism is concerned, but they are not as practical as the other type because they cannot be turned in as small a radius and the power is reduced materially when one track is braked.

The second or steering clutch type, is more complicated and requires more attention. The axles are a direct drive from the ring gear and pinion to the final drive and each track operates at the same speed. In order to turn the tractor, each axle operates through a multiple dry-disc clutch very similar to the master clutch. These clutches are equipped with a hub and throw-out bearing and are controlled by levers and rods which connect them to the steering levers or wheel.

These two clutches require the same attention as the master clutch in regard to cleaning and adjusting. They are not, in most cases, lubricated automatically from a final drive, but this should be checked against the lubrication chart for each type and make of tractor.

Oil works out of the transmission and final drive cases, gets into these clutches and causes the discs to become gummed. The discs should be cleaned by taking off the inspection plates and then proceeding along the same lines in the cleaning of the master clutch. After they have been cleaned, they should be lubricated when necessary and all cleaning solvent and dirt removed from the housing.

When the clutches slip, grab, or fail to disengage, it is usually because they are dirty or out of adjustment. This adjustment is rather fine on most tractors and unless the operator is thoroughly familiar or has had previous experience with this particular type clutch, he should never attempt to adjust it. A skilled mechanic should check the clutch and make adjustments when necessary.

The operator should never slip or apply pressure on the steering clutches except when changing direction of the tractor; such a practice will cause excess wear on the pilot and throw-out bearings and burn the clutch facings.

# TRACK ROLLER FRAME ASSEMBLY

## LESSON VIII

The principal of the tracks on a crawler-type tractor is quite simple and very efficient as they form an endless track for the tractor to operate on. The weight of the tractor is distributed over the entire area of the lower section of the track which affords much better traction and permits the tractors to be used in sand, mud, and soft dirt where a wheel-type tractor would be useless.

The track assembly consists of the main frame, truck wheels, track-links, track-shoes, idler-wheels, adjusting-springs, springs, and spring-hangers.

The main frame usually is formed of a steel casting or channel irons which not only supports the engine, transmission, and final drive, but holds them in the proper relation to each other. The rear part of the frame is mounted on a shaft which supports the weight of the rear part of the tractor proper. The drive-sprockets are mounted in the shaft and permit a hinge motion of the tracks. An equalizer-bar or cross-member supports the weight of the front of the tractor. Springs are mounted on either side of the front of the motor and attached to the equalizer-bar to permit the track to conform to uneven ground.

The entire weight of the tractor is carried on the tracks by the roller-frame assembly which consists of plain and flanged rollers. These rollers work on the same principal as

the tracks of a railroad car, the track-wheels on each side corresponding to the wheels of a railroad car. These track-wheels bear on the upper side of the track, which forms a continuous rail for the track-wheels to run on.

Mounted on the front of the frame assembly between the steel, side-channels, is the blank-sprocket or idler-wheel. This idler is mounted, so that it can be moved forward or backward by means of a long, threaded, adjusting bolt. One or more coil springs are provided to keep the correct tension on the tracks and allow flexibility to the tracks, should a rock or stick hang in the tracks. The idler-wheels keep the track lined-out in front of the machine and allow the tracks to be adjusted. The weight of the top of the tracks is supporting rollers which are practically the same as the lower track rollers.

The equalizer-bar carries the load of the front of the tractor and also keeps the two track frames parallel and properly spaced. The sprocket-shaft holds the rear end of the track-frames in proper adjustment and also in line with the motor and tractor body.

There are several types of track but they are all on the same principal. Some types have track-links which consist of side-bars and pins with rollers between the side-bars. The track-shoes are bolted to the links on this type track and the grousers or cleats on the track-shoes are cast in one piece with the track-shoe. Another popular type of track has the link and track-shoe cast in one piece and these shoes or track-links are

connected together by pins and rollers. On this type track, the grousers are equally bolted to the track shoes or links.

The links are long enough so that every other tooth on the drive-sprocket engages a roller on the track-pins. The track-shoe pins and rollers are heat treated or case hardened to reduce the wear on them. Since the track operates continuously in dirt, sand, and mud, the links should not be oiled as oil would have a tendency to hold this grit on them and materially increase the wear on the drive-sprocket, rollers, and pins.

When it becomes necessary to break a track or take it apart, the operator should know how to do it. There are two general types; one type has all loose or master pins. This type track is very convenient as it can be taken apart at any link, but since these pins are all free in the track links, there is more wear on the track links and pins. The other type track has the pins placed under pressure in the track-links and has one free pin or master link. This is the more practical type track as there is less wear on the pins and links.

The idler-wheels are mounted on a stationary shaft and have either a roller bearing or a bronze bushing. If tracks are adjusted too tightly, an unnatural strain is thrown on the bearing or bushings. Should they become worn, the idler-wheel wobbles and throws the tracks out of line. The adjustment or tension of the tracks is very important and a general rule to follow is that of having the track just tight enough

enough so that the tops can be raised in the center about two inches above the supporting rollers. Some type tractors have one adjusting bolt for each track and this type track is fairly easy to adjust. The other type has an adjusting bolt on either side of the idler-bearing, and, in adjustment of this type track, care should be taken to see that both bolts have the same tension.

In case that the tracks toe-in or become out of alignment the operator should report it to the mechanic and let him determine what is causing the trouble.

The track-rollers on some tractors have roller-bearings and a grease-fitting for each set of rollers. Grease retainers are provided on either side of the bearing to retain the grease and to prevent mud, dirt, and water from entering the bearings. This type roller should be greased every ten hours and sufficient grease should be pumped into each bearing, to come out past the grease retainer and remove any foreign matter that might be working into the bearing.

Other type tracks have bronze bushings and cork or felt retainers to hold the grease in and foreign matter out. Usually where the "one show" oiling system is used the track rollers are of this type and have cork grease retainers. This is a very convenient method of oiling the track rollers, but care should be taken to see that all rollers or moving parts get oil.

The importance of lubricating the idler-wheels and track-rollers cannot be over emphasized. The instructions in the lubricating manual should be followed closely.

## TRACTOR ATTACHMENTS

### LESSON IX

Various manufacturers have made any number of attachments to be operated in connection with tractors. The power is transmitted through a shaft from the transmission to the power take-off, which is mounted on the rear or side of the tractor. A sliding-gear is on the drive end of this shaft and is engaged with a drive-gear in the counter or drive-shaft or the transmission by means of a shifting-fork and lever. This power can be applied or controlled by the master clutch the same as the power to the drive-sprockets.

A common use of the power take-off is to operate compressors, concrete mixers, and rock crushers. This is a very simple operation and usually the tractor is set in place and the power is transmitted by a drive-belt from a flat pulley on the power take-off. Since there is no way to reverse the ordinary power take-off, it sometimes becomes necessary to put a single twist in the belt which changes the direction of the driven pulley on the equipment being operated.

When setting a tractor to be used as power plant, with the driving done with a flat belt, care should be exercised to see that the pulleys are lined perfectly or the belt will not stay on. This may be accomplished by sighting across the edges of the drive pulley or the driven pulley and moving one end of the tractor in the direction necessary to align the two pulleys. The flat or driving surfaces of the drive and driven pulleys should be parallel and in line.

When a tractor is being used as a power plant, it should be set level. The operator should watch the oil pressure and motor temperature and see that is is properly lubricated just as if it were being used on draw-bar work. Ordinarily the tractor when used this way, runs at a constant speed and has a tendency to run hot; so the radiator should be checked often.

Unless the operator has other work he must perform, he should remain on the tractor, so that he can cut off the power or stop the tractor immediately in case of an emergency.

One other common use of the tractor is a direct-drive power unit for portable rock crushers. When used in this way, a special gear reduction is necessary, and is secured by the use of an oil-tight case with reduction gears which fastens direct to the power take-off. A lever is provided to engage or disengage this unit so as to control the power to the crusher. Power is transmitted to the crusher by use of universal joints and a tumbler-shaft which is in two sections. The male and female section of this shaft are splined, so that the whole unit will be flexible when moving over uneven ground. In moving a unit of this kind over very uneven ground or sharp breaks, such as ditches or a rocky ledge, the operator should uncouple the tumbler-shaft. Otherwise, the universal joints may not allow sufficient movement and the tumbler-shaft will be bent.

The tractor requires the same care on this kind of work as on other work and the operator should service and lubricate the crusher at the same time he shuts down to service the tractor.

This is a more or less hazardous operation, and the operator should remain at the controls of the tractor at all times when it is in operation. Should the crusher hang on a large rock or a man get his hand or foot hung in the jaws, the operator should be in a position to cut off the power at once. Care should be used in working around a unit of this kind not to step over the tumbler shaft or get too close to any moving parts where clothing might be caught. A guard should be provided for the tumbler-shaft to prevent any accidents.

Another use of the tractor is in connection with a hoist. There are three types of hoist; namely, the front, side, and rear hoist. All of these are driven from the power take-off. Some of these hoists are single driven and others have double drums, depending upon the work to be done. Some types are mounted on the rear of the tractor and connected direct to the power take-off shaft. Other types have a small gear box or auziliary transmission mounted on the power take-off from which the power is transmitted to the hoist by a drive chain or V-type belt. This transmission usually has two or more speeds and a reverse which is controlled by a shifting-lever. The drums on the ordinary hoist are equipped with large brake bands, so that the drums can be locked or the line fed out very slowly. Other type hoists have an irreversible, worm drive and the line is fed out under power. The Soil Conservation Service does not use very many of these

hoists, but a brief description has been given so the enrollee would have a general knowledge of the principal, should he have to operate a tractor equipped with a hoist. Only experienced operators should be used in this kind of work.

The most popular attachment for tractors, as used by the Soil Conservation Service, is the hydraulic-controlled trailbuilder or bulldozer. This piece of equipment is becoming very popular with contractors and any number of enrollees have left camps to accept positions with contractors as bulldozer operators.

Some of the larger types of bulldozers in use by contractors are operated mechanically by means of drums and cables rather than by hydraulic jacks. The operating principal is very similar, and, if a man can operate the hydraulic type, he can soon learn to operate the other type.

The hydraulic system consists of the following: a hydraulic, gear-type pump, a relief valve, a control valve, two hydraulic hoists, base, and fittings. The principle and arrangement of this system is practically the same on all tractors. It is through this system that power is applied to raise and lower the mold board. The hydraulic pump draws oil from the oil tank through a low-pressure hose; raises the oil to a pressure and sends it through high-pressure tubes and on through the relief valve and thence to the control valve where the oil is directed at the will of the operator to the top or bottom of the pistons which will raise or lower the central arms on both sides of the machine. These arms are

heavy, cast-steel levers connected to the piston rod on one end and by means of long bolts and springs to the moldboard on the other end.

The hydraulic pump is a simple gear-pump consisting of two bronze gears on shafts which are mounted on roller bearings on either end. Oil seals are provided to prevent the pump from leaking, making no adjustments necessary on the pumps, so that it should last the life of the machine if no grit or foreign matter is allowed to get into the oil. This pump is lubricated by the oil it pumps, so it should never be operated unless there is oil in the tank.

The relief valve consists of the case, the relief valve proper, the relief-valve spring, and the adjusting screen. The pumps operate continuously and the purpose of the relief valve is to prevent the pressure from becoming too great in the high-pressure lines and cylinders. When the pressure reaches the amount required, the valve opens and allows the oil to flow back to the tank. The adjustment of this valve as controlled by the adjusting screw is very important and should be made by a skilled mechanic. If there is not sufficient tension on the relief-valve spring, the oil will by-pass to the tank and make the operation of the hoists very slow and sluggish. If there is too much tension on the spring, it creates an abnormal pressure on the high-pressure lines and control valve. If this valve gives trouble, only a skilled mechanic should attempt to repair it.

The control valve permits the operator to direct the oil pressure to the top or bottom of the piston and raise or

lower the moldboard. It consists usually of a cast-steel body with posts cast in it and an integral, cast-bronze core with posts cast in it. By moving the core to different positions, it aligns the different posts which allows the oil to flow to the top or bottom of the pistons or back to the tank. The core is generally mounted on ball bearings and is controlled by a lever. An adjusting screen is provided to control the clearance between the bronze core and the side walls of the case. Only a skilled mechanic should attempt to make this adjustment.

The hydraulic-hoist assembly consists of two, steel cylinders with a pressure-tight steel base, two nickel cast-iron pistons fitted with pistons rings, piston rods, heads, and packing glands. This assembly should require no adjustment throughout its life. The cylinder-head should be kept tight at all times and the packing-gland nuts taken up as the chevron packing around the piston rod wears.

All pipe and hose connections should be kept tight at all times to prevent the oil from leaking or air from entering the system. Use only the grade oil recommended by the manufacturer and special care should be exercised to see that no dirt, sand, water, or other foreign matter ever enters this system; if it does, it will cause all moving parts to cut and wear.

The moldboard frame and other parts require very little attention other than to be cleaned and lubricated regularly with all parts kept perfectly tight.

Only an experienced operator should be placed on a tractor equipped with a bulldozer; he should be able to operate his tractor almost automatically, so that his entire attention can be given to the work he is doing.

Never use a tractor equipped with a bulldozer on draw-bar work. If it becomes necessary to road a tractor or use it on draw-bar work, the moldboard should be taken off.

## SUMMARY AND SAFETY REGULATIONS

### LESSON X

It is difficult to set down a set of safety rules pertaining to tractor operation. The work is exceptionally hazardous and the majority of accidents connected directly or indirectly with tractors result in serious loss of time or fatalities. The operator of a tractor has not only his own safety to consider but that of the man working on the job with him.

When a tractor is being employed in the maintenance or betterment of a road that is being used by the public, the road should be posted. A sign should be placed in the center of the road or on a shoulder where the motorist can easily see it and know that a tractor or grader is working ahead. Otherwise, a serious collision might occur on a sharp curve or hill resulting in serious injury or death to the occupant of the car. If the road is properly posted, the liability then becomes that of the motorist. At times, it is more advisable to use a flagman both in the front and rear of the equipment. These men can clean catch-basins, throw oversize rock off the road, and do other labor when not actually flagging a car.

When operating a tractor in a gravel pit, bull-dozing, or doing other close work, the operator should always watch the men working around the machine. He should always look back before he reverses the machine, and never push rocks

or dirt over the fill as they might roll down on a workman.

An operator should never attempt to get on or off the tractor when it is in motion. He should never allow a swamper or any other person to stand on or hold onto the tracks or track frames when the tractor is in motion. Neither should he allow a swamper to ride on the hood, gas tank, or any part of the tractor where he might fall off when the tractor is put in motion.

When bulldozing or working on a steep, hill-side section of road or a fill the operator should be very careful not to get the tractor too close to the edge of the fill where it might turn over. If it does turn over, it is very hard for the operator to jump clear of the machine.

In working on a tractor or other heavy equipment, the operator should wear gloves to protect his hands. Should a wrench slip and the hand be cut or bruised, iodine or other germicide should be applied immediately to prevent infection.

Never remove the cap from the radiator when the motor is over heated. Allow the motor to cool so that it is not boiling. Otherwise, steam and hot water may blow out and scald the face and hands. When operating in heat, dust, or during windy weather, an operator should always wear goggles to protect his eyes.

As stated in the introduction to this course, the intention was not to develop expert tractor mechanics, but to explain and familiarize the enrollees with common-sense operation rules and safety practices.

The enrollee who has attended all classes and taken a genuine interest in the work should be much better off, and should feel that the time has been well spent. He should be able to perform his duties much better as a tractor operator in the Civilian Conservation Corps, and to fill a like position in a creditable manner after his return to civil life.

The enrollee should review the entire course before coming to the last class meeting, and prepare himself for the examination. In grading the man, the interest he has taken in his work on the job, and the way he has performed his duties should be considered by the instructor.